The following article presents a view of future trends in lubrication as perceived by Paramins at their recent Autotrends 98 seminar in London. They focused on three dominant issues i.e. fuel economy, cost of ownership and driver convenience.

As ever, future trends are driven mainly by legislation, notably those concerning exhaust emissions.

**CARBON DIOXIDE EMISSIONS**

Despite the proactive line of the European Union taken to meet the requirements agreed at the Kyoto conference in 1997, the European Commission are not satisfied with the steps so far taken. In December 1997, the Environment Council urged the Commission to propose a Directive with binding reduction goals, with a CO2 fleet average of 120g/km by 2008 being suggested as a target. In March, the motor industry responded with an offer of 140g/km, but only if there were no unreasonable restrictions on diesel vehicles, if there was full availability of low sulphur fuel by 2005, and if there was a full availability of fuels with appropriate fuel economy features such as cetane numbers. This offer has received a sympathetic hearing, and the Environment Council have asked the Commission to start work on the technical details.

**VEHICLE EMISSIONS AND FUEL SPECIFICATIONS**

Consensus on passenger car emissions and fuel quality for 2000 has almost been reached between the Council of Ministers and the European Parliament although there are still significant differences in the areas of diesel sulphur and the gasoline aromatic contents as shown in Table 1. The 2005 proposals, which are much tougher on diesel passenger cars compared with gasoline proposals, as shown in Table 2, and are likely to go to 'conciliation'.

The current and proposed emission limits for the various groups of vehicles are shown in Table 3. It is understood that the 2005 emissions and fuel specifications may be mandated now but may be reviewed at a later stage after the year 2000. There are also European proposals for new emission limits for heavy duty diesels for 2000, for which two new test procedures have been developed to reflect real world conditions, namely a steady state cycle with a dynamic smoke test (ESC/ELR) for conventional engines, and a European transient test (ETC) for engines with advanced aftertreatment such as de-NOx catalysts and/or particulate traps.

**VEHICLE ENGINEERING**

Probably the most significant development is the GDI (gasoline direct injection) engine, which is starting to appear in certain vehicles marketed by Mitsubishi, Toyota and Nissan. Apart from the direct injection of gasoline into the cylinder as opposed to the normal indirect system, the predominant feature of this system is the sophisticated engine management system which, coupled with lean burn air/fuel ratios of as low as 50:1, provide exceptional fuel economy together with acceptable driveability. Introduction into the European market has been delayed by the need to modify catalyst systems to operate with the higher fuel sulphur levels in Europe. Toyota, for example, who use a 'storage and reduction' treatment system as an integral part of their design philosophy, will have a particular problem.
with the relatively high-sulphur European fuels. Other possible problem areas include injector wear from inadequate fuel lubricity, also deposit formation in injectors and elsewhere.

It is as yet unknown whether there will be a need to optimise lubricants for this type of engine.

**Hybrid vehicles** are becoming more of a commercial reality with the development of better electronics and increasing pressures for fuel economy. The Toyota Prius vehicle, for example, uses a 1.5 litre gasoline engine as a primary power source. The power output is split between direct vehicle propulsion via the electric motor and electricity generation for storage, the generator also acting as a starter motor. The stored electricity is used when extra power is required. Although the system is complex and expensive, fuel economy gains are obtained by ensuring that each power source operates at optimum efficiencies. It is again unclear as to whether such vehicles will have any special requirements in terms of fuels and lubricants.

**Fuel cells** were described in some detail in the previous issue of ‘LUBE’, and will not therefore be described in further detail here.

‘Common rail’ systems for injection engines use a stable high pressure fuel delivery system which is then subsequently fed to the injectors. The main advantage of pre-pressurising the fuel in this way is that the injection timing and fuel quantity delivered is decoupled from the injection system, being controlled instead by the engine management system. The use of higher pressures than is usual results in cleaner combustion and lower emissions. Also the timing may be instantaneously adjusted to optimise the timing according to economy or emission requirements. The injection profile may be modified if necessary to incorporate pilot injection, also the system is inherently quieter than the conventional distributor or ‘jerky’ pump system.

When considering **exhaust aftertreatment**, the situation for conventional gasoline cars is well established, the main problem area being the low efficiency during following cold starting or during short runs. However, for GDI lean-burn engines, a new de-NOx technology is required, which does not seem to be directly transferable to situations involving using fuels with a higher sulphur content. Mitsubishi have modified their catalyst system, the replacement selective reduction system sacrifices performance for compatibility with high-sulphur European fuels. The Toyota system, which absorbs NOx as nitrate under lean-burn conditions and then reduces it to nitrogen when operating stoichiometrically, does not work satisfactorily with high-sulphur fuels. For diesel engines, improvements in fuel injection will enable emissions to meet the 2000 legislation requirements without resorting to de-NOx catalysts or particulate traps, the latter not being favoured because of their inherent unreliability. However, the 2005 requirements are much more severe, and will not be able to be met with current technology without the use of after treatment devices. One system which is currently being investigated is Selective Catalyst Reduction (SCR), using ammonia derived from urea. However, health concerns are now directed towards the invisible finer particles in diesel emissions rather than the overall particulate mass. If this becomes the chief concern, then the use of particulate traps will become necessary.

**REFINERY TRENDS**

Prospect for oil refiners is now considerably brighter than they were a few years ago, with increasing demand requiring many plants to operate at 90% capacity in the main consuming areas, although the competitive nature of the industry has led to several acquisitions and joint ventures. The overall fuel balance requirement continues to swing to diesel, resulting in a surplus of gasoline and a deficit of middle distillates. Forthcoming legislation to reduce sulphur levels will require additional investment in desulphurisation capacity; other challenges are presented by the required reductions in aromatics and, in particular, benzene contents. New technologies are being investigated to meet these challenges, including biocatalytic desulphurisation, where enzymes selectively remove sulphur from petroleum products.

**DIESEL FUEL LUBRICITY**

Problems experienced with inadequate fuel lubricity of low-sulphur diesel fuels have now been overcome by suitable additive treatment where necessary, with fuel lubricity

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**TABLE 3**

<table>
<thead>
<tr>
<th>Engine Type</th>
<th>Pollutants</th>
<th>Gasoline Cars &amp; LCVs</th>
<th>Diesel</th>
<th>Passenger Cars &amp; LCVs</th>
<th>LCVs Class II</th>
<th>LCVs Class III</th>
<th>Heavy Duty Engines</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996/97</td>
<td></td>
<td>3.30</td>
<td>2.50</td>
<td>0.30</td>
<td>0.25</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td>2.30</td>
<td>1.70</td>
<td>0.30</td>
<td>0.25</td>
<td>0.20</td>
<td>0.20</td>
</tr>
</tbody>
</table>

1. **All limits expressed on the year 2000 test cycle (with 40 seconds warm-up period omitted).**
2. **All limits expressed on ESC/ETC and ETC cycles applicable from year 2000 (EURO III).**
3. **Hydrocarbons are not subjected to regulation, only NOx are regulated.**
4. **For heavy-duty engines, HC is treated individually.**

Source: European Commission
specifications and satisfactory test procedures now established. However, concerns over contamination of military and civil aviation fuel have arisen when diesel fuel is shipped down multi-product pipelines. UKPIA have accordingly developed a Code of Practice on the use of new additives in pipelines.

ALTERNATIVE FUELS
The prospect of using alternative fuels is of not inconsiderable significance to the lube oil manufacturer, since there is the prospect of qualitative and quantitative impact on the associated lubricants. Compressed natural gas and liquefied petroleum gas are likely to increase in proportion, although initially at least, usage is likely to be restricted to buses and other public service vehicles. In spite of a major government campaign and European promotion, biofuels do not seem to be popular as yet, which is not surprising in view of the high costs and limited availability. CEN is in the process of developing a specification for FAME (fatty acid methyl ester) which is the normally accepted form in which as PC-7) is just may be used as fuels. This trend by fuel is Elf Aquitaine’s Aquazole, which is an emulsion of water in diesel fuel. The concept of adding water to fuel, normally by water injection, is not new, but the benefits of reductions in NOx and particulates in this case could boost the prospects of Aquazole, although there are a number of problem areas still to be overcome.

CRANKCASE LUBRICANTS
The ACEA 98 modifications which now include a requirement to provide minimum fuel economy benefits have been widely publicised. Also welcome is a new sense of order involving the introduction and withdrawal of specifications in that up to 1 March 1999 it will still be permitted to launch products that claim ACEA 96 performance levels, but from that date all new products making any claim to ACEA specifications will need to satisfy ACEA 98 performances. Their has been a certain amount of questioning by OEMs regarding the introduction of the new B4 category, since this requirement appears to be mainly driven by Volkswagen only. This again raises the question as to why should OEMs have their own specifications when the ACEA requirements already seem comprehensive enough? It would appear that OEMs such as Daimler-Benz, BMW, Porsche, VW etc., seek extra performance and that oil marketers recognise the marketing benefits of such additional product features on their packaging.

HEAVY DUTY DIESEL CRANKCASE LUBRICANTS
Cost of ownership and durability are the main issues here, with increased attention being paid to lengthening drain intervals. NOx emissions can be reduced by retarding injector timing, but at the expense of higher oil-borne soot loading, which can result in filter plugging. API CH-4 (previously known as PC-7) is intended to address this trend by incorporating a Mack T-8E filter plugging test. However, CH-4 does not specifically address the long-drain requirement; this is left to the various OEMs to determine suitability and make recommendations. In the US, emission requirements will dictate the use of exhaust gas recirculation (EGR), although there are as yet no specific tests. JAMA’s intention is to support a new category, PC-8, which will address wear protection of slider cams and lifters. SE Asia is also calling for a CD+ type oil, although the exact requirements are unclear.

It is possible that an ACEA category may suffice.

GLOBALISATION
There is much talk of the ‘globalisation’ of fuels, lubricants, OEM requirements, etc. although with the differences which currently exist, such speculation may be somewhat premature, although cooperation is increasing. For the additive industry, there is a clear need to establish consensus on the minimum standards for test procedures, before addressing specifications any further. Paramos see no point in proliferation beyond the current API, ILSAC, JAMA and ACEA.

TRANSMISSION FLUIDS
By 2005 over 35% of passenger cars in Western Europe will be equipped with automatic gearboxes, as opposed to the current 15%, and this figure is likely to rise to over 50% by 2015. Continuously variable transmissions (CVTs) will become standardised, with emphasis now turning to continuously slipping torque converter clutches (CSTCCs). These developments will call for optimised lubricants, perhaps even OEM-specific. Operating conditions will become more severe in terms of smaller gearboxes, higher temperatures, and increased drain intervals, possibly fill-for-life. Since current lubricants do not adequately meet the specific requirements of new-generation CVTs, let alone CSTCCs, there will be further developments in the field of automatic transmission fluids, new fluids probably being of lower viscosity with enhanced oxidation and thermal stability.

SMALL ENGINES
Utilisation of small engines is increasing rapidly, both as a result of the improvement of conditions in the developing countries, with more people able to afford personal transport, albeit of a basic variety, and in the developed countries, where increase in small engine use is linked to both recreational use and portable power generation. Environmental considerations in terms of exhaust emissions favour the use of four-stroke engines, although two-stroke engines, which are still used in 70% of motorcycles, are enjoying something of a revival due to efficiency improvements resulting from new lubricant, fuel, injection and catalyst technologies.

Water-cooled two strokes used for recreational marine use are particularly in the environmental spotlight, and the biodegradability performance is an essential part of the specification. For motorcycle use, some OEMs in Europe regard the API HC with JASO FB as a minimum quality standard with ISO EGD as the highest quality. Others consider that an improved lubricity and detergency is required, as specified in the so-called ‘EGE’. Increased ‘tailoring’ of lubricants for higher-powered four stroke motorcycle use has been necessary, since the range of operating conditions are significantly different to those of automobile engines. In particular, problems have been experienced in the use of friction modifiers, since certain components of the motorcycle powertrain, e.g. the clutch, back torque limiter and starter drive, all of which are lubricated by the engine oil, depend on controlled frictional characteristics for satisfactory operation. A new specification has now been proposed by JASO, but has not yet been adopted as a standard.

David Margaroni
In order to assist those members who are in the process of developing their own quality system, the BLF Technical Officer is in the process of compiling a generic quality manual which can be applied to virtually all organisations. It is based on the requirements of BS EN ISO 9002:1994, which is a model for quality assurance in production, installation and servicing, and in itself may be used as the reference document for such a system. The manual is obviously designed to apply to the lubricants industry, and is therefore rather more tailored to the industry than the ISO standard itself, which is designed to cover a whole variety of industries and operations. However, because of the generic nature of the document, company-specific procedures are obviously not included. Individual companies are expected to compile their own procedural manuals and documentation records. Additional notes in the BLF Manual will provide some guidance on writing out necessary procedures, etc.; if necessary additional help could be provided on a company-by-company basis from the BLF at competitive rates.

Fundamental to the quality system is the development and suitable in-house publicity of a company Quality Policy.

Such a policy should define the quality objectives and commitment of a company to quality, and be relevant to the organisational goals of the company, and to the expectations and needs of its customers. Stipulated objectives are to be achievable, properly planned and periodically reviewed.

The Quality Policy should stipulate that the primary objective of any organisation is to consistently meet the needs and expectations of all of its customers at all times, or wording to that effect. The quality policy forms one, albeit extremely important, element of corporate policy and must be authorised and fully supported by top management.

To achieve the stipulated requirements of the quality policy the organisation must ensure that customer requirements, both stated and implied, are properly understood, that service standards, product quality, safety and performance meet the needs of the customer, and that products, processes and operations comply with applicable standards, specifications and statutory requirements. At the same time, the quality policy should declare a commitment to continuous improvement, and also be circulated and publicised in such a fashion that all staff are aware of the company quality requirements. For organisations conforming to, or aspiring to, accreditation to ISO 9000, there must be statement to this effect in the policy. Finally, there must also be a statement to the effect that the policy is fully supported by the most senior management of the company.

The requirements of such a policy are clear enough and few would argue with the general philosophy if they want to remain in business. However, such statements, although readily made, are not so easy to put into effect. In order to comply with, and to demonstrate compliance, it is necessary to devise a quality system which will deliver the necessary assurances.

The quality system defines in detail the organisational structure, procedures, processes and resources needed to implement quality management.

The BLF manual is based directly upon the requirements of ISO 9000 and is structured in an identical fashion. It therefore addresses the requirements relating to their own procedures, but it will indicate where such procedures are required. The quality manual is therefore virtually a re-write of the ISO 9000 requirements, but written in a form which describes how the various requirements of ISO 9000 are met by the organisation concerned.

David Margaroni

As can be seen, the BLF manual follows the ISO 9000 system exactly. The benefit of this approach is that all aspects of the standard are covered, and it is far easier system for an external auditor to follow. However, as already stated, the BLF manual is generic and, as such, contains no organisational specifics. It does not absolve an organisation from the responsibility of developing and compiling